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TESTING CONDITIONS FOR ENERGY STAR® MEASUREMENT MULTIFUNCTION DEVICES

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In order to eliminate confusion and ensure consistency, the following protocol should be followed when measuring power under the ENERGY STAR® Multifunction Device (MFD) Program.

I. TEST CONDITIONS

Line Impedance:	< 0.25 ohm
Total Harmonic Distortion: (Voltage)	< 3%
Ambient Temperature:	21 deg. C +/- 3 deg. C
Relative Humidity:	40 - 60 %
Distance From Wall:	2 ft. min.

Other Market-Specific Criteria:

Market	Paper Size	Voltage/ Frequency
United States	8.5" x 11"	115 V RMS +/- 5 V 60 Hz +/- 3Hz
Europe, New Zealand	A4	230 V RMS +/- 10 V 50 Hz +/- 3 Hz
Japan	A4	100 V RMS +/- 5 V 50 Hz +/- 3 Hz and 60 Hz +/- 3 Hz 200 V RMS +/- 10 V 50 Hz +/- 3 Hz and 60 Hz +/- 3 Hz

Partners shall perform tests on their products based on the market in which the product will be sold. For example, a Program Participant that is shipping a multifunction device to Europe must determine the multifunction device speed based on A4 paper, and then measure the power consumption using the voltage and frequency values specified for the European market. For equipment that is rated at multiple input voltages and sold in multiple international markets, the Program Participant must test at all rated voltages if it plans to display the ENERGY STAR logo on the product in all markets.

All supplies used shall be those specified by the MFD manufacturer and preconditioned for a minimum of 24 hours at room ambient temperature prior to evaluating the MFD power rating.

AC power shall be supplied as a true sine wave.

II. TEST METHOD

Manufacturers should measure the **Average** power consumption of their MFD products when in the low-power and/or sleep mode. This should be done by measuring the **Energy** consumption over a 1-hour period. The resulting energy consumption can be divided by 1 hour to calculate average Watts.

A. Sleep Mode Power Measurement

Prior to the start of this test, the machine should be plugged into a live power line but turned off and stabilized at room ambient conditions for at least 12 hours. An appropriate watt-hour meter should be in line with the machine, ready to give an accurate indication of machine energy consumption without disruption of the power source.

Turn on the multifunction device, and let it go through its warm-up cycle. When it is ready to make a hard-copy output, make one copy or print one page, then wait exactly the amount of time specified in Tables 1, 2, 3, or 4 of the MFD MOU for the multifunction device to enter the sleep mode. After the appropriate delay time has passed, read and record the watt-hour meter indication and the time (or start the stopwatch or timer). After 1 hour, read and record the watt-hour indication again. The difference between the two readings of the watt-hour meter is the sleep mode energy use; divide by 1 hour to obtain the average power rating.

B. Low-Power Mode Power Measurement

Prior to the start of this test, the machine should have been plugged into a live power line but turned off and stabilized at room ambient conditions for at least 12 hours. An appropriate watt-hour meter should be in line with the machine, ready to give an accurate indication of machine energy consumption without disruption of the power source. This measurement may be done sequentially with the sleep mode power measurement; the two tests together should take no more than about 14 hours to perform, including the time required for the machine to be plugged in and turned off.

Turn on the multifunction device, and let it go through its warm-up cycle. Make one copy or print one page, then wait exactly 15 minutes (for medium, medium/high, and high-speed MFDs only). After 15 minutes has passed, read and record the watt-hour meter indication and the time (or start the stopwatch or timer). After 1 hour, read and record the watt-hour indication again. The difference between the two readings of the watt-hour meter is the low-power mode energy use; divide by 1 hour to obtain the average power rating.

III. TESTING EQUIPMENT

The goal is to accurately measure the TRUE power consumption[1] of the MFD. This necessitates the use of a **True RMS** Watt-Hour Meter, one per phase, accurate to three figures. There are many watt-hour meters to choose from, but manufacturers will need to exercise care in selecting an appropriate model. The following factors should be considered when purchasing a meter and setting up the actual test.

Crest Factor

To begin, it is important to understand that MFDs which contain switching power supplies draw current in a waveform different from typical sinusoidal current.[2] Figure 1 shows the typical

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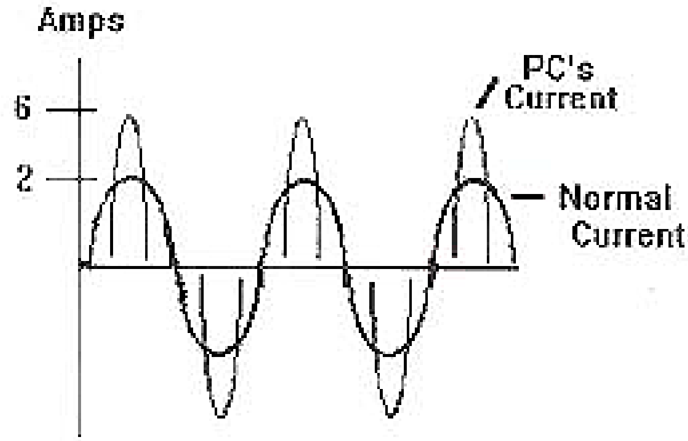
1 True power is defined as (volts)x(amps)x(power factor), and is typically reported as Watts. Apparent power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0; so true power is always less than apparent power.

2 The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with a MFD containing a switching power supply will always be greater than 1.4 (though typically no

current waveform for a multifunction device with a switching power supply. While virtually any meter can measure a standard current waveform, it is more difficult to select a meter when irregular current waveforms are involved.

Figure 1



It is critical that the meter selected be capable of reading the current drawn by the MFD without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor,[3] and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges.

When preparing the test, the first step should be to determine the peak current (amps) associated with the MFD being measured. This can be accomplished using an oscilloscope. Then a current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope.   For example, if a watt-hour meter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If measured peak current is only 6 amps, the meter would be satisfactory. The other concern to be aware of is that if the current range is set too high in order to register peak current, it may lose accuracy in measuring the non-peak current. Therefore, some delicate balancing is necessary. Again, with more current range choices and higher crest factors Partners will get better results.

Frequency Response

Another issue to consider when selecting a watt-hour meter is the frequency response rating of the meter. Electronic equipment that contains switching power supplies causes harmonics (odd harmonics typically up to the 21st). These harmonics must be accounted for in measurement, or the energy and power consumption will be inaccurate. Accordingly, EPA recommends that manufacturers purchase watt-hour meters that have a frequency response of at least 3 kHz. This will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution

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higher than 8). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).

[3] The crest factor of a watt-hour meter is often provided for both current and voltage. For current, it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average True RMS watt-hour meter has a crest factor in the range of 2:1 to 6:1.

Manufacturers will probably want a meter that can provide resolution of 0.1 W.

Accuracy

Another feature to consider is the resulting accuracy that can be achieved. Catalogues and specification sheets for watt-hour meters typically provide information on the accuracy of energy and power readings that can be achieved at different range settings. When measuring a product that is very close to EPA specifications, Partners will need to set up a test that will provide greater accuracy. For example, if the resulting accuracy for a watt-hour meter at the test settings is ± 0.5 W, then be sure the measured power consumption of the MFD is within at least 0.5 W of the EPA specification.

Calibration

Watt-hour meters should be calibrated every year to maintain their accuracy.